Fracking fury

Science Scope, March 2012

Hydraulic fracturing, also known as "fracking" or "hydrofrack-ing," seems to be everywhere these days. Reports on major news networks, on Nation-al Public Radio, and online are aplenty. There have even been antifracking protests within the Occupy Wall Street movement. What is hydraulic fracturing and why is it such a hot topic? This month's column will address these questions and the concerns surrounding the issue.

Hydraulic fracturing

Hydraulic fracturing (HF) is an unconventional technique in gas production that has been around in some form since the 1940s (EPA 2011; NYT 2011). The gas extracted through HF is highly dispersed in rock, instead of in a concentrated underground location, and dispersed gas is produced only by special stimulation techniques. This relatively recent method has opened up new areas of gas development in natural gas reservoirs such as shale, coalbed, and tight sands (EPA 2011). (This article will focus on HF in shale reservoirs.)

Shale gas refers to natural gas that is trapped in shale (fine-grained sedimentary rock) formations. In 2009, about 14% of natural gas production came from shale formations. Shale gas is found in shale "plays"--shale formations with significant amounts of natural gas. Important plays include the Marcellus Shale in the eastern United States and Barnett Shale in Texas (see Figure 1) (U.S. EIA 2011).

How it works

HF creates fractures in the rock formation that stimulate the flow of natural gas. Wells are drilled vertically hundreds to thousands of feet below the land surface and can include horizontal or directional sections extending thousands of feet. Fractures are created by pumping large quantities of fluids at high pressure down a wellbore into the target rock formation. The fluids consist of millions of gallons of water, chemical additives, and proppants (sand, ceramic pellets, or other incompressible particles) that open and en-large fractures within the rock formation. Fractures can extend hundreds of feet away from the wellbore. The proppants hold open the newly created fractures and natural gas flows from the shale to the well (EPA 2011; U.S. EIA 2011) (see Figure 2).

After fluids have been injected, the internal pressure of the rock formation causes the fluid to return to the surface. Known as "flowback" or "produced water," this fluid can contain the injected chemicals as well as naturally occurring materials (hydrocarbons, brines, metals, and radionuclides). The flowback is stored on site in tanks or pits before treatment, disposal, or recycling. Often, it is injected underground for disposal. Flowback can also be treated and reused or processed at a wastewater treatment plant and then discharged to surface water (EPA 2011).

Pros

HF is a booming, rapidly growing industry. Advocates cite the generation of domestic jobs and revenue as a benefit of HF (NYT 2011). As compared to other natural resources (e.g., coal and oil), natural gas is cleaner (NYT 2011). The combustion of natural gas emits significantly lower levels of carbon dioxide, nitrogen oxides, and sulfur dioxide than the combustion of coal or oil. The natural gas produced through U.S. HF operations means less reliance on foreign sources of natural gas (U.S. EIA 2011).

Cons

Hazards associated with natural gas production and drilling are not as well known as with other fossil fuels, and regulations have not kept pace with production (NYT 2011). Escalating concerns include adverse effects on drinking water, human health, animals, and ecosystems.

Water

Perhaps the greatest concern with HF is the effect on water, including drinking-water supplies. Concerns about potential indirect impacts include surface discharge of wastewaters, depletion of drinking-water supplies, and methane migration (NYT 2011) (see The Fuss Over Fracking video in Resources).

During the fracturing process, injected fluids can flow to other areas of the formation ("fluid leakoff"); if not controlled, fluid leakoff can reach 70% of the injected volume and may result in fluid reaching drinking-water aquifers (NYT 2011). Stray gas and drill-ing fluids can migrate from abandoned wells at drilling sites to aquifers, drinking wells, or homes (NYT 2011).

In Pavillion, Wyoming, the EPA found high levels of benzene, acetone, toluene, and naphthalene; traces of diesel fuel; and at least one chemical used in HF (the solvent 2-Butoxyethanol) in environmental monitoring wells drilled deep into an aquifer. The area has been drilled extensively for gas production over the past 20 years and has hundreds of gas wells. Some residents have experienced neurological impairment, loss of smell, and nerve pain (Lustgarten and ProPublica 2011).

Massive quantities of water are needed in HF operations, and there are concerns over the effect of with-drawing large amounts of water from local surfaceor groundwater sources. In North Dakota, an estimated 5.5 billion gallons of water per year are needed to re-lease oil and gas from the Bakken Shale (NYT 2011).

Waste treatment plants that treat wastewaters from HF operations are not designed to remove the contaminants (e.g., chlorides and radionuclides) in the water before it is released into rivers (NYT 2011). Solid wastes produced by water treatment plants (salts or sludge) and their disposal need to be evaluated (NYT 2011).

Human health

One study found that people living near HF sites experienced negative health effects due to contaminated water. The health effects included burning of the nose, throat, and eyes; headaches; as well as neurological, dermatological (rashes), vascular (nose-bleeds), sensory, immunological, urological, and gastrointestinal (vomiting, diarrhea) issues. The exposure occurred when contaminated well or spring water was used for drinking, cooking, showering, and bathing (Bamberger and Oswald, Forthcoming).

Animal health

Cows, goats, and chickens have died due to exposure to drilling waste and emissions (NYT 2011). A study of animals near HF sites in Colorado, Louisiana, New York, Ohio, Pennsylvania, and Texas found that the animals' exposure to contaminated water wells, springs, ponds, or creeks had detrimental health effects (reproductive, dermatological, musculoskeletal, gastrointestinal, urological, upper respiratory, and neurological health effects, as well as sudden death). Cows, horses, goats, llamas, chickens, dogs, cats, and koi were affected. Dead and dying wildlife in the area included deer, songbirds, frogs, fish, and salamanders. In one location, 17 cows died

(due to respiratory failure with circulatory collapse) within an hour of being exposed to HF fluid (Bamberger and Oswald Forthcoming).

Earthquakes

Earthquakes have occurred in numerous locations where HF was taking place. Two earthquakes shook Youngstown, Ohio, in December 2011--both within 0.8 km from the injection well and 100 m from each other. Nine earthquakes have occurred between March and November 2011 within an 8 km radius of the disposal site (wastewater injection well) in Ohio. The quakes were caused by a slippage of the fault at the same depth as the injection site, about 3 km below the surface. It is not the initial drilling nor the injection of water with proppants that seems to cause the earthquakes, but the reinjection of the wastewater back into the ground (into equally deep sandstone) as a form of disposal. Injection fluids are implicated in other strike-slip earthquakes close to deep-injection wells; the fluids can act as lubricants between two abutting rocks, helping them to slip along the boundary. The area, which has experienced earthquakes for about a year, could face up to another year of earth-quakes, even with operations suspended (Fischetti 2012). Earthquakes have also occurred in Tex-as and Arkansas; Oklahoma has experienced a tenfold increase in earth-quakes since 2009 to over 1,000 (McAllister 2012).

Pollution

There are myriad concerns about pollution from HF operation sites. Underground fissures can extend uncontrollably for miles beyond a drilling site, which could create a pathway for gas or fluids to migrate and become a hazard (NYT 2011). Toxic materials can be carried from drilling sites by storm runoff or leak from waste disposal sites (NYT 2011). Spills, blowouts, or leaks can occur from pits used to store wastewater (NYT 2011).

One study found wastewater from the Marcellus wells had increased concentrations over time of total dissolved solids, chloride, barium, calcium, water hard-ness, and levels of radioactivity (NYT 2011).

Air emissions from vehicles transporting water and proppants increase air pollution, and bacteria brought up from fracking creates air pollution, as well (NYT 2011).

Regulation and industry loopholes

In 2005, Congress passed legislation that included an exemption for HF from the protections of the Safe Drinking Water Act, the Clean Water Act, and the Clean Air Act. The natural gas industry is currently exempt from major sections of the following (Sierra Club 2011):

* Clean Water Act: Requires a permit for dumping large amounts of produced water into waterways

* Safe Drinking Water Act: Protects drinking-water quality and limits "underground injection" of waste

* Clean Air Act: Strengthens standards for air pollutants to keep air clean

* National Environmental Policy Act: Requires a full environmental review for all major federal actions on public land

* Emergency Planning and Community Right-to-Know Act: Requires producers of toxic substances to report to the EPA any storage, release, or transfer of significant toxic substances

* Resource Conservation and Recovery Act: Sets safeguards for the handling of hazardous and solid wastes

The Fracturing Responsibility and Awareness of Chemicals Act of 2011 was proposed to Congress in March 2011. The act would mandate that corporations involved in HF disclose all chemicals used in HF operations (currently they are kept secret), with the exception of proprietary information. If passed, HF operations would no longer be exempt from the Safe Drinking Water Act (Thomas-Blate 2011).

Public involvement

As a current issue, HF is attracting the public's attention and involvement. In New York, 20,000 public comments were submitted with the state's environmental officials concerning the proposal to allow HF in the state. Gas industry representatives are pushing for less restrictive rules; environmental groups are pushing for detailed plans concerning HF wastewater, potential health risks to humans, and the effects on the environment; others are asking that HF be banned altogether. New York has banned drilling up-state near the watersheds that supply drinking water to New York City. New York City officials are requesting a seven-mile buffer zone between HF drilling sites and underground aqueducts and tunnels (due to a concern about seismic activity and its potential to affect the NYC water supply). New York State, however, is proposing a 1,000-foot buffer (Navarro 2012).

EPA study

The Environmental Protection Agency is currently conducting a study on HF. However, the study will only focus on potential impacts to drinking-water resources; potential effects on air, ecosystems, animals, occupational risks, and so on will not be examined. The study will identify such topics as areas for further research (EPA 2012). The study should be released at the end of 2012, with another report due in 2014; some portions of the study will continue over the long term. The study will examine five retrospective case studies of drinking-water contamination due to HF in North Dakota, Texas, Pennsylvania (two sites), and Colorado. Two prospective sites (in Louisiana and Pennsylvania) will be monitored during future HF processes (EPA 2012).

Conclusion

Because HF is a relatively new technology, the process from start to finish has not been fully assessed. The upcoming release of the EPA study will determine the future direction of HF operations and hopefully establish firm regulations to protect human and animal health and the environment.

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Resource

The Fuss Over Fracking: The Dilemma of a New Gas Boom- www.time.com/time/video/player/0,32068r876880045001_2062814,00.html

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Source Citation

Pallise, Janna. "Fracking fury." *Science Scope* Mar. 2012: 20+. *Science In Context*. Web. 5 Nov. 2013.

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Gale Document Number: GALE|A294903454